DENSITY, ULTRASONIC VELOCITY, VISCOSITY AND THEIR EXCESS PARAMETERS OF THE BINARY MIXTURES OF 2- METHYL ANILINE WITH 1-ALKANOLS (C₃-C₈) AT DIFFERENT TEMPERATURES

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ABSTRACT

Measurement of densities (ρ), ultrasonic velocities (u) and viscosities (η) has been carried out for binary mixtures of 2-methylaniline (2-MeA) with 1-alcohols (1-propanol, 1-butanol, 1-pentanol, 1-hexanol, 1-heptanol, and 1-octanol) and their pure liquids at 298.15K and 308.15 K. These experimental data have been used to calculate excess volume (V^E), deviation in ultrasonic velocity (Δu), deviation in isentropic compressibility ($\Delta\kappa_s$), deviation in intermolecular free length (ΔL_f), deviation in acoustic impedance (ΔZ), deviation in viscosity ($\Delta\eta$) and excess Gibbs free energy of activation of viscous flow (G^{*E}). The variation of these properties with composition of the mixtures suggests hydrogen bonding, dipole-dipole interaction, specific acid-base interactions and dispersive forces. The magnitude of the property is found to depend on the chain length of 1-alcohols. The viscosity data have been correlated using three equations: Grunberg and Nissan, Katti and Chaudhri, and Hind et al. These results have been fitted to the Redlich - Kister polynomial using multiparametric nonlinear regression analysis to derive the binary coefficients and to estimate the standard deviation (σ).

KEYWORDS: Ultrasonic Velocity, Viscosity, Density, Excess Thermodynamic Parameters

INTRODUCTION

The thermodynamic properties of a binary mixture such as density, ultrasonic speed, and viscosity are important from practical and theoretical points of view to understand liquid theory. Their properties are extremely useful for the design of process equipment in chemical industries. In chemical process industries materials are normally handled in fluid form and as a consequence, the physical, chemical, and transport properties of fluids assume importance. Thus the data of the properties associated with the liquids and liquid mixtures like density, ultrasonic velocity and viscosity find extensive application in solution theory and molecular dynamics. Such results are necessary for interpretation of data obtained from thermochemical, electrochemical, biochemical, and kinetic studies.

The present paper is a part of our ongoing research program in the measurement of thermodynamic properties of binary liquid mixtures [1-5]. The liquids were chosen in the present investigation on the basis of their industrial importance. Alcohols are used as hydraulic fluids in pharmaceutical and cosmetics, in medications for animals, in manufacturing of perfumes, paint removers, flavors and dyestuffs, as defrosting and as an antiseptic agent. 2-methylaniline is used in the manufacture of dyes, rubber vulcanization accelerators, hypnotic and anesthetic pharmaceuticals, and pesticides. The experimental results have been used to discuss the nature of interaction between unlike molecules in terms of hydrogen bonding, dipole-dipole interaction, specific acid-base interaction and dispersive forces. It is well known that amines interact with alcohols by dipole-dipole interactions, formation of new hydrogen bonds or hetero-associates and dispersion forces [6-8]. A survey of the literature has shown that experimental data on thermodynamic property for binary

mixtures of methyl cyclohexane with ethanol, 1-propanol, 2-propanol, 1-butanol, 2-methyl-1-propanol, 3-methyl-1-butanol [9], 2-methoxy ethanol with diethyl aniline and triethyl aniline[10], m-cresol with substituted anilines [11], 2-(2-butoxy ethoxy) ethanol with aniline and N-alkyl anilines [12] while that on 2-methylaniline with alcohols is relatively rare. The main intention of present work is to study the effect of chain length of alcohol and to analyΔZ the interactions of the hydroxyl group, that may influence both the sign and magnitude of excess functions, when mixed with 2-methylaniline. We report here the excess volume (V^E), deviation in ultrasonic velocity (Δu), deviation in isentropic compressibility ($\Delta \kappa_s$), deviation in intermolecular free length (ΔL_f), deviation in acoustic impedance (ΔZ), deviation in viscosity ($\Delta \eta$) and excess Gibbs free energy of activation of viscous flow (G^{*E}) of the binary systems: 2-methylaniline with homologous series of aliphatic alcohols (1-propanol, 1-butanol,1-pentanol, 1-hexanol, 1-heptanol and1-octanol) at 298.15K and 308.15 K. These results have been fitted to the Redlich - Kister polynomial using multiparametric nonlinear regression analysis to derive the binary coefficients and to estimate the standard deviation (σ).

EXPERIMENTAL

Materials

The mass fraction purity of all the liquids from S.D Fine Chemicals, Ltd., India was as follows: 2-methylaniline (0.995), 1-propanol (0.995), 1-butanol (0.995), 1-pentanol (0.990), 1-hexanol (0.985), 1-heptanol (0.995) and 1-octanol (0.996). Prior to making the experimental measurements, all the liquids were used after double distillation and partially degassed with a vacuum pump under an inert atmosphere. The purity of all these solvents were compared with the measured density and speed of sound and viscosity of the pure liquids with the literature [13-20] and these are given in Table 1.

Apparatus and Procedure

The water content of solvents used in this work was measured by Analab (MicroAqua Cal 100) Karl Fischer Titrator and Karl Fisher reagent from Merck. It can detect water content from less than 1×10^{-5} to 100 % by conductometric titration with dual platinum electrodes. All the binary liquid mixtures were prepared by weighing appropriate amounts of pure liquids on an electronic balance (Afcoset, ER – 120A, India) with a precision of ±0.1 mg by syringing each component into airtight stopper bottles to minimiΔZ evaporation losses. The uncertainty of the mole fraction was ± 1×10^{-4}. Densities of the pure liquids and their mixtures were measured by using Rudolph Research Analytical Digital Densitometer (DDM-2911model) and these measurements were carried by carefully filling the sample in the U tube of the instrument with the help of medical syringe. We have also ensured that no bubble formation during the measurement since cell should be air-free. The density was measured automatically at the specified temperature with an accuracy of±0.00005 g·cm-3. The instrument was calibrated once each day with double-distilled, deioniΔZd water and air as standards. The uncertainty in the density measurement is ±2×10^{-5}g·cm-3. The ultrasonic velocity measurements were performed using a commercially available single crystal ultrasonic interferometer (model F-05) from Mittal Enterprises, New Delhi, India, at 2MHz frequency at various temperatures. A thermostatically controlled, well-stirred circulated water bath with a temperature controlled to ±0.01 K was used for all the ultrasonic velocity measurements. The uncertainty in the measured velocity of sound is ±0.5 m· s^{-1}. The viscosities of pure liquids and their binary mixtures were measured by using an Ostwald's viscometer. The viscometer was calibrated with pure water and liquid was allowed to stand for about 30 minutes in a thermostatic water bath so that the thermal fluctuations in viscometer were minimiΔZd. The accuracy in viscosity data was ± 0.005 mPa. s

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RESULTS AND DISCUSSIONS

The experimental values of density (ρ), ultrasonic velocity (u) and viscosity (η) of pure liquids and their mixtures as function of mole fraction of 2-methylaniline at 298.15K and 308.15 K were used to calculate the parameters such as V^E, κ_s, $\Delta\kappa_s$ and $\Delta\eta$ from experimental data using the following expressions:

$$V^E = [x_1 M_1 + x_2 M_2]/\rho - [x_1 M_1/\rho_1 + x_2 M_2/\rho_2] \tag{1}$$

$$\kappa_s = u^{-2}\rho^{-1} \tag{2}$$

$$\Delta\kappa_s = \kappa_s - [x_1 \kappa_{s1} + x_2 \kappa_{s2}] \tag{3}$$

$$\Delta\eta = \eta - [x_1 \eta_1 + x_2 \eta_2] \tag{4}$$

In the above equations, M_1, M_2, κ_{s1}, κ_{s2}, η_1, η_2, u_1, u_2, ρ_1, ρ_2, ρ, κ_s, η, and u represent molecular weight, isentropic compressibility, viscosity, ultrasonic velocity and density data of component 1, component 2 and mixture respectively.

The data related to excess volume (V^E), deviation in isentropic compressibility ($\Delta\kappa_s$) and deviation in viscosity ($\Delta\eta$) for the binary systems of 2-methylaniline with 1-propanol, 1-butanol, 1-pentanol, 1-hexanol, 1-heptanol, and 1-octanol were graphically represented in Figures 1 to 6 respectively at 298.15K and 308.15 K.

Excess Volume

The V^E data of all the binary mixtures of 2-methylaniline with 1-propanol, 1-butanol, 1-pentanol, 1-hexanol, 1-heptanol, and 1-octanol are graphically presented in Figures 1 and 2 at 298.15 K and 308.15 K respectively.

A perusal of curves in Figure 1 indicates that the values of V^E data for mixtures of 2-methylaniline with 1-hexanol, 1-heptanol and 1-octanol are positive. On other hand, an inversion in sign for the binary mixtures containing 2-methylaniline with 1- propanol, 1-butanol, and 1-pentanol was observed. Further, it is observed that magnitude of negative V^E values decreases with increase in composition of 2-methylaniline.

According to Marcus [21], the molecules of 1-alcohols are associated through hydrogen bonding in pure state. Mixing these alcohol molecules with polar molecules like 2-methylaniline would induce mutual dissociation of the hydrogen-bonded structures present in pure alcohols with subsequent formation of inter molecular hydrogen bonds (N----HO) between the nitrogen atom of amino group of 2-methylaniline molecule and hydrogen atom of hydroxyl group of 1-alcohols. Further, the curves in Figure 1 also reveal that, as the chain length of 1-alkanol molecule increases from 1-propanol to 1-octanol, the negative excess volume tends to shift towards positive excess volume which implies that dipole-dipole interactions are becoming weak in the higher 1-alkanols owing to the decrease in their polarizability [22]. Also the positive excess volume suggests that the higher alcohols less proton donating ability than the lower alcohols. Hence hetero association effects decrees in the binary mixtures with an increase of chain length of linear alcohols [23]. The algebraic values of V^E for the mixtures of 2-methylaniline with1-alcohols fall in the order:

1-propanol< 1-butanol < 1-pentanol< 1-hexanol < 1-heptanol< 1-octanol

The order suggests that dipole-dipole interactions between unlike molecules decrease with increasing in chain length of alcohols as a consequence of the decreases the degree of polymerization in the pure sate.

Experimental results suggest that the negative excess volume can be attributed to the dipole – dipole interactions between unlike molecules through hydrogen bonding and positive values indicate that , the breaking up of self-associated

structures of the components of the mixtures is dominant over the effect of H-bonding and dipole-dipole interaction between unlike molecules

Excess Isentropic Compressibility ($\Delta\kappa_s$)

The deviation in isentropic compressibility ($\Delta\kappa_s$) data of all the binary mixtures of 2-methylaniline with 1-propanol, 1-butanol, 1-pentanol, 1-hexanol, 1-heptanol and 1-octanol are graphically presented Figures 3(a, b) and 4(a, b) at 298.15 K and 308.15 K respectively.

An examination of curves in Figure 3a and Figure 3b shows that the values of $\Delta\kappa_s$ data for 2-methylaniline with 1-propanol, 1-butanol, and 1-pentanol are negative and for the remaining binary mixtures $\Delta\kappa_s$ is positive over the entire composition range at 298.15 K**.**

The $\Delta\kappa_s$ values were ascribed according to Sri Devi et al [24] the negative excess values have been due to the closely packed molecules which account for existence of strong molecular interaction where as positive excess values are due to prevailing of dispersion forces between unlike molecules. The sign of deviation in isentropic compressibility ($\Delta\kappa_s$) and deviation in intermolecular free length (ΔL_f) play a vital role in assessing the compactness due to molecular interaction in liquid mixtures through hydrogen-bonding, charge-transfer complex formation and dipole-dipole interactions and dipole-induced dipole interactions, interstitial accommodation and orientational ordering [25] leading to more compact structure making negative excess isentropic compressibility and excess intermolecular free length values.

A perusal of curves in Figures 3a and 3b shows that the ($\Delta\kappa_s$) negative value decreases may be attributed to hetero association complexes decrease with increasing chain length, probably due to less proton-donating ability of higher alcohols. Experimental results suggest that the negative values of deviation in isentropic compressibility ($\Delta\kappa_s$) and deviation in intermolecular free length (ΔL_f) for binary mixtures attributed to the dipole-dipole interactions through formation of complexes between the molecules of mixing components and the positive values of deviation in isentropic compressibility ($\Delta\kappa_s$) and deviation in intermolecular free length (ΔL_f) for binary mixtures may be due to the domination of dispersion forces over formation of complexes between unlike molecules.

The $\Delta\kappa_s$ values of 2-methylaniline with alcohols fall in the order:

1-octanol< 1-heptanol < 1-hexanol < 1-pentanol < 1-butanol < 1- propanol

Deviation in Viscosity

An examination of curves in Figures 5 and 6 suggests that the values of $\Delta\eta$ are positive for 2-methylaniline with 1-propanol, 1-butanol, and 1-pentanol and is negative for the remaining mixtures over the entire composition range at 298.15 K and 308.15 K respectively. According to Fort and Moore [26] deviation in viscosity tends to become more positive as the strength of the interaction between component molecules increases. The deviation in viscosity gives a qualitative estimation of the strength of the intermolecular interactions. The deviation in viscosity is influenced by [27] (i) the difference in siΔZ and shape of the component molecules and the loss of dipolar association to a decrease in viscosity (ii) Specific interactions between unlike molecules such as H-bonding formation and charge transfer complexes may cause for the increase in viscosity in mixture rather than in pure component. The former effect produces negative excess viscosity and latter effect produces positive excess viscosity. Positive values of $\Delta\eta$ are an indication of strong interactions whereas a negative value indicates weaker interactions [28].

An examination of curves in Figures 5 shows that the positive $\Delta\eta$ values are indicative of specific interactions between component molecules while the negative $\Delta\eta$ values suggest that dispersion forces are dominant in mixtures. The

existence of dispersion forces indicates that the component molecules have different molecular siΔZs and shapes.

From experimental results suggest that the positive values of $\Delta\eta$ may be attributed to the formation of hydrogen bonding (O-H….N) resulting in the formation of complexes between the component molecules and negative values suggest that the rupture of hydrogen bonded chain of the dipolar interaction between solute and alcohol exceed the intermolecular interaction through dipole-dipole and hydrogen bonding between solute and alcohol.

The algebraic values of deviation in viscosity for binary mixtures of 2-methylaniline with alcohols fall in the order:

1-octanol <1-heptanol < 1-hexanol < 1-pentanol < 1-butanol < 1-propanol

According to Reed et al [29] the positive values of $G*^E$ may be attributed to specific interactions between unlike molecules, such as hydrogen bonding, dipole-dipole interaction, charge-transfer complex and dispersion forces which generally are responsible for negative deviations in the property. In the present work the positive values of $G*^E$ may be attributed to specific interactions through of hydrogen bonding (O-H….N) resulting in the formation of complexes between the component molecules.

Viscosity Models and Interaction Parameters: With a view towards correlations, the viscosities of binary liquid mixtures with those of component liquids and interpreting the molecular interactions in these mixtures. Several equations have been put forward from time to time. These are given in the following text.

Grunberg and Nissan [30] suggest that the values of d_{12} are positive for all binary mixtures over the entire composition range at 298.15 K and 308.15 K.

Fort and Moore [26] and Ramamoorthy [31] reported that for any binary liquid mixture, a positive value of d_{12} indicates the presence of specific interactions and a negative value of d_{12} indicates the presence of weak interactions between the unlike molecules. In the present work the positive values of d_{12} may be attributed to the specific interactions between unlike molecules and negatives values suggesting breaking of the self-associated alcohols and weak interactions between unlike molecules. A similar observation was made by Subba et al [32] from the d_{12} values of the binary liquid mixtures of propionic acid with alcohols.

Katti and Chaudhri [33] values (W_{vis}/RT) of the binary mixtures suggest that the values of W_{vis}/RT are positive for all binary mixtures over the entire composition range at 298.15K

Hind et al.[34] values (H_{12}) of binary mixtures shows that interaction parameter are positive for all binary mixtures over the entire range of composition, suggesting strong dipole-dipole interactions in lower alcohols and weak dipole-dipole interactions in high alcohols. In the present study, the value of H_{12} increases with increase of alkyl chain length in N,N-diethyl aniline $_+$ of alcohols implies that dipole-dipole interaction is weaker in higher alcohols [35].

The variation of V^E, $\Delta\kappa_s$, and $\Delta\eta$ with mole fraction were fitted to the Redlich-Kister polynomial equation [36] of the type,

$$Y^E = x_1 x_2 [a_0 + a_1(x_1 - x_2) + a_2(x_1 - x_2)^2] \tag{5}$$

where Y^E is V^E or $\Delta\kappa_s$ or $\Delta\eta$. The values of a_0, a_1 and a_2 are the coefficients of the polynomial equation and the corresponding standard deviations, σ obtained by the method of least – squareswith equal weights assigned to each point are calculated. The standard deviation (σ) and are defined as:

$$\sigma\,(Y^E) = [\textstyle\sum(Y^E_{\ obs} - Y^E_{cal})^2/(n\text{-}m)]^{1/2} \tag{6}$$

Where n is the total number of experimental points and m is the number of coefficients. The values of a_0, a_1 and a_2 are the coefficients is determined by a multiple-regression analysis on the least square method and summariΔZd along with the standard deviations between the experimental and fitted values of V^E, Δu, $\Delta\kappa_s$, $\Delta\eta$ are presented in Table 2. Finally, it can be concluded that the expressions used for interpolating the experimental data measured in this work good results, as can be seen by inspecting the σ values obtained.

CONCLUSIONS

 From experimental results, negative V^E and $\Delta\kappa_s$ values can be attributed to the dipole –dipole interactions between unlike molecules through hydrogen bonding and positive values indicate that the effect due to breaking up of self-associated structures of the components of the mixtures is dominant over the effect of H-bonding and dipole-dipole interaction between unlike molecules

The positive values of $\Delta\eta$ and G^{*E} may be attributed to the formation of hydrogen bonding (O-H….N) resulting in the formation of complexes between the component molecules and negatives values suggesting breaking of the self-associated alcohols and weak interactions between unlike molecules. From these data, several thermodynamic excess functions have been calculated and correlated using the Redlich – Kister type polynomial equation. The sign and magnitude of these quantities have been discussed in terms of hydrogen bond, electron-transfer complexes and dipole-dipole interactions between the component molecules.

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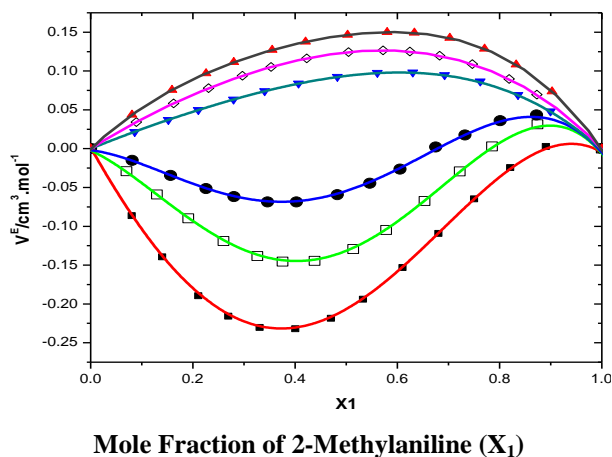36. O. Redlich, A.T. Kister, Ind. Eng. Chem 40 (1948) 345-348

APPENDICES

Mole Fraction of 2-Methylaniline (X_1)

Figure 1: Variation of Excess Molar Volume (V^E) with Mole Fraction (x_1) of 2-Methylaniline in the Binary Liquid Mixtures of 2-Methylaniline with 1-Propanol (■), 1-Butanol (□), 1-Pentanol (●), 1-Hexanol (▼), 1-Heptanol (◊), 1-Octanol (▲) at 298.15 K

Mole Fraction of 2-Methylaniline (X_1)

Figure 2: Variation of Excess Molar Volume (V^E) with Mole Fraction (x_1) of 2-Methylaniline in the Binary Liquid Mixtures of 2-Methylaniline with 1-Propanol (■), 1-Butanol (□), 1-Pentanol (●), 1-Hexanol (▼), 1-Heptanol (◊), 1-Octanol (▲) at 308.15 K
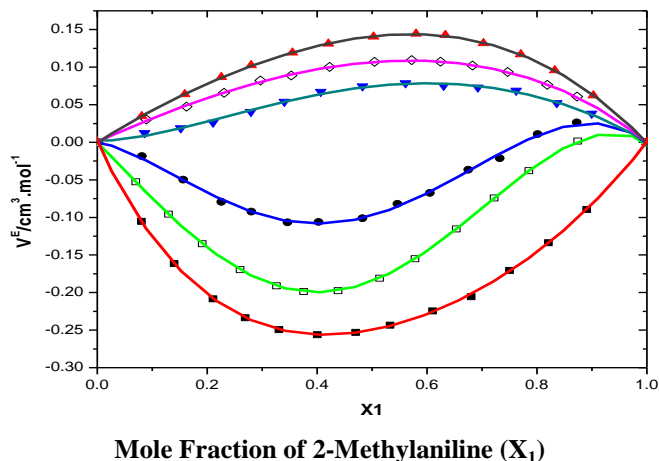

Mole Fraction of 2-Methylaniline (X_1)

Figure 3a: Deviation in Isentropic Compressibility ($\Delta\kappa_s$) with Mole Fraction (x_1) of 2-Methylaniline in the Binary Liquid Mixtures of 2-Methylaniline with 1-Propanol (■), 1-Butanol (□), 1-Pentanol (●) at 298.15 K

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Mole Fraction of 2-Methylaniline (X$_1$)

Figure 3b: Deviation in Isentropic Compressibility ($\Delta\kappa_s$) with Mole Fraction (x$_1$) of 2-Methylaniline
in the Binary Liquid Mixtures of 2-Methylaniline with 1-Hexanol ($\blacktriangledown$), 1-Heptanol ($\diamond$),
1-Octanol ($\blacktriangle$) at 298.15 K

Mole Fraction of 2-Methylaniline (X$_1$)

Figure 4a: Deviation in Isentropic Compressibility ($\Delta\kappa_s$) with Mole Fraction (x$_1$) of 2-Methylaniline
in the Binary Liquid Mixtures of 2-Methylaniline with 1-Propanol ($\blacksquare$), 1-Butanol ($\square$),
1-Pentanol ($\bullet$) at 308.15 K

Mole Fraction of 2-Methylaniline (X$_1$)

Figure 4b: Deviation in Isentropic Compressibility ($\Delta\kappa_s$) with Mole Fraction (x$_1$) of 2-Methylaniline
in the Binary Liquid Mixtures of 2-Methylaniline with 1-Hexanol ($\blacktriangledown$), 1-Heptanol ($\diamond$) ,
1-Octanol ($\blacktriangle$) at 308.15 K

Mole Fraction of 2-Methylaniline (X$_1$)

**Figure 5: Deviation in Viscosity ($\Delta\eta$) with Mole Fraction (x$_1$) of 2-Methylaniline
in the Binary Liquid Mixtures of 2-Methylaniline with 1-Propanol (■), 1-Butanol (□),
1-Pentanol (●), 1-Hexanol (▼), 1-Heptanol (◇), 1-Octanol (▲) at 298.15 K**
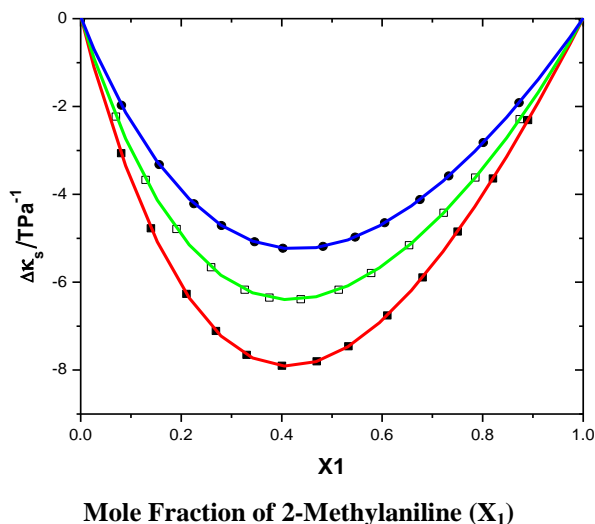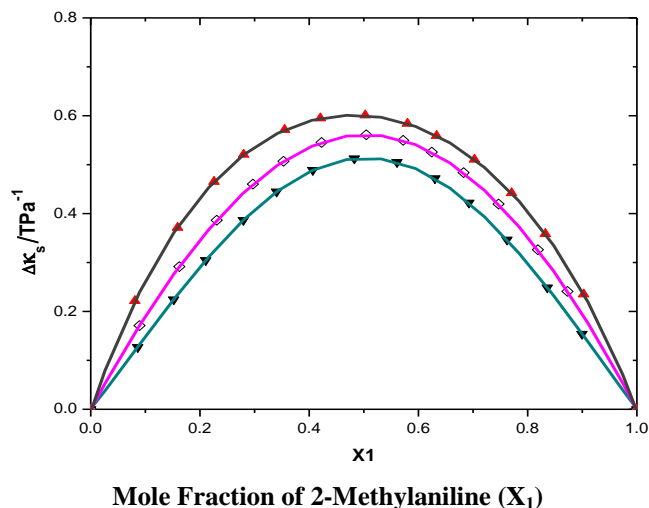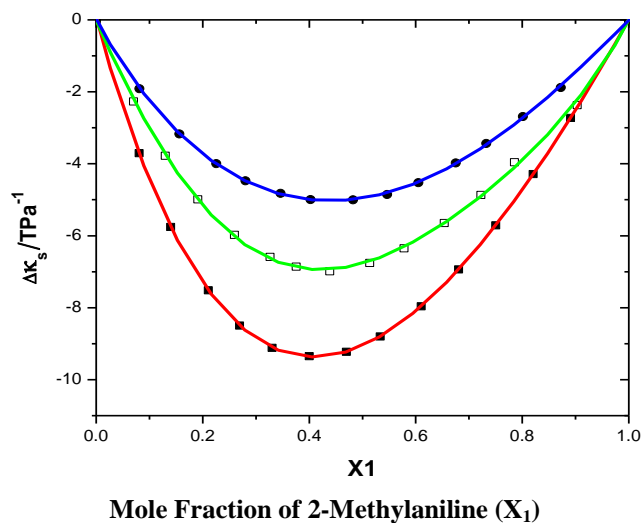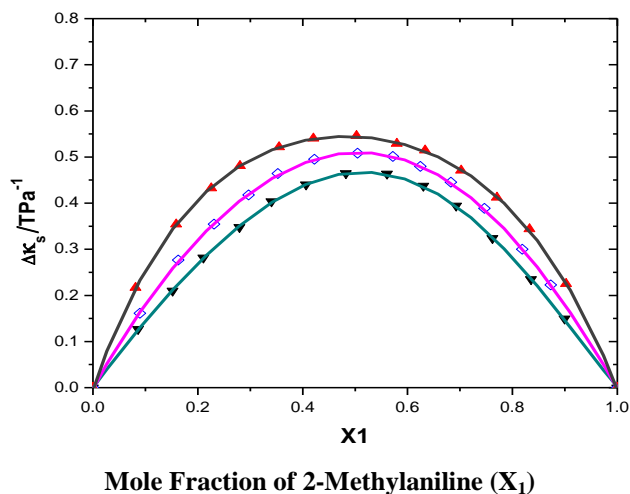

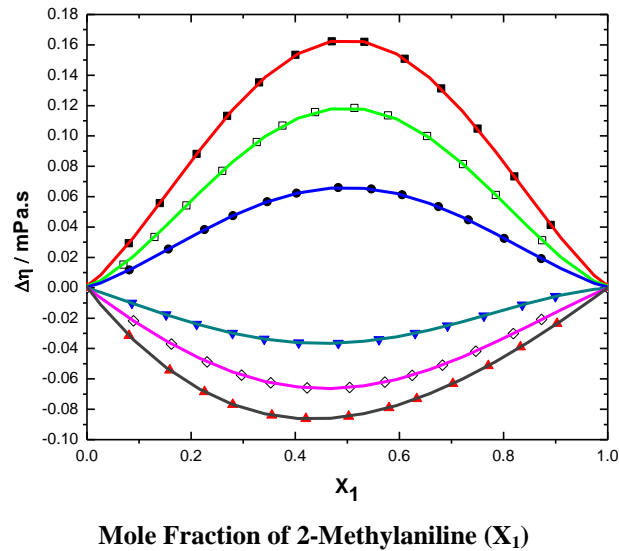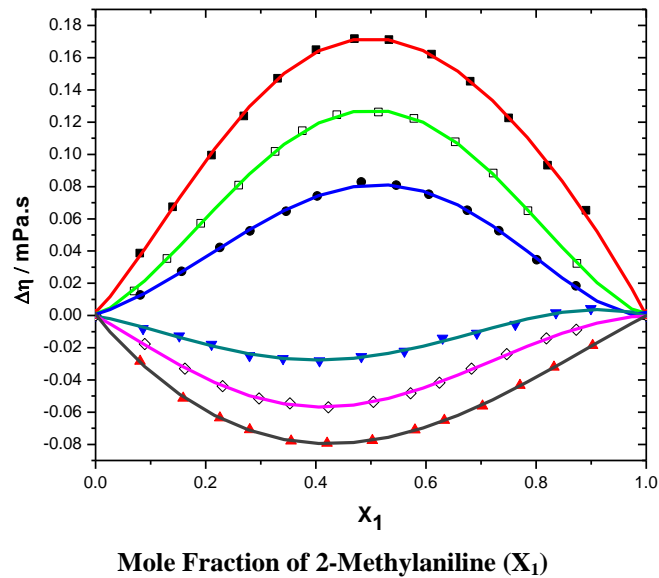**Mole Fraction of 2-Methylaniline (X$_1$)**

**Figure 6: Deviation in Viscosity ($\Delta\eta$) with Mole Fraction (x$_1$) of 2-Methylaniline
in the Binary Liquid Mixtures of 2-Methylaniline with 1-Propanol (■), 1-Butanol (□),
1-Pentanol (●), 1-Hexanol (▼), 1-Heptanol (◇), 1-Octanol (▲) at 308.15 K**

**Table 1: Comparison of Experimental and Literature Values of Density (ρ), Ultrasonic
Velocity (u) and Viscosity (η) for Pure Components at 298.15 K**

Pure Components	ρ (g cm^{-3})		u (m s^{-1})		η (mPa s)	
	Experimental	Literature	Experimental	Literature	Experimental	Literature
2-methylaniline	0.99434	0.99430[b]	1601.8	1603.0[b]	3.738	3.725[c]
1-propanol	0.79963	0.79960[a]	1203.7	1206.3[g]	1.945	1.943[a]
1-butanol	0.80573	0.80570[d]	1231.8	1244.0[f]	2.572	2.5609[d]
1- pentanol	0.81113	0.8111[h]	1268.3	1274.32[f]	3.349	3.347[d]
1-hexanol	0.81520	0.81523[e]	1305.1	1304.72[e]	4.591	4.593[e]
1-heptanol	0.81871	0.81873[e]	1328.2	1327.32[e]	5.946	5.944[e]
1-octanol	0.82169	0.82172[e]	1346.7	1347.82[e]	7.658	7.661[e]

[a] Reference[13], [b] Reference[14], [c] Reference[15], [d] Reference[16], [e] Reference[17], [f] Reference[18],
[g] Reference[19], [h] Reference[20].

Density, Ultrasonic Velocity, Viscosity and Their Excess Parameters of the Binary Mixtures
of 2- Methyl Aniline with 1-Alkanols (C$_3$-C$_8$) at Different Temperatures

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**Table 2: Experimental Values of Density (ρ), Ultrasonic Velocity (u), and Calculated Values
of Excess Volume (V^E), Deviation in Ultrasonic Velocity (Δu), Isentropic Compressibility(κ$_s$),
Deviation in Isentropic Compressibility (Δκ$_s$) Intermolecular Free Length (ΔL$_f$) and Specific
Acoustic Impedance (ΔZ) for the Binary Mixtures at 298.15K and 308.15K**

Binary Mixtures	Functions	a$_0$	a$_1$	a$_2$	σ
2-methylaniline + 1 propanol	V^E (cm^3 mol^{-1})	-0.834	0.764	0.435	0.0006
	Δκ$_s$ (TPa^{-1})	-30.790	10.772	-6.555	0.0931
	Δη(mPa s)	0.653	-0.003	-0.370	0.0001
2-methylaniline + 1 butanol	V^E (cm^3 mol^{-1})	-0.533	0.537	0.743	0.0001
	Δκ$_s$ (TPa^{-1})	-24.918	7.898	-3.192	0.0001
	Δη(mPa s)	0.474	-0.006	-0.332	0.0003
2-methylaniline + 1 pentanol	V^E (cm^3 mol^{-1})	-0.221	0.426	0.533	0.0012
	Δκ$_s$ (TPa^{-1})	-22.397	6.103	-1.051	0.0001
	Δη(mPa s)	0.264	-0.004	-0.158	0.0001
2-methylaniline + 1 hexanol	V^E (cm^3 mol^{-1})	0.377	0.161	0.048	0.0003
	Δκ$_s$ (TPa^{-1})	2.055	0.039	-0.594	0.0001
	Δη(mPa s)	-0.145	0.042	0.076	0.0001
2-methylaniline + 1 heptanol	V^E (cm^3 mol^{-1})	0.492	0.125	0.086	0.0014
	Δκ$_s$ (TPa^{-1})	2.245	0.031	-0.173	0.0001
	Δη(mPa s)	-0.263	0.057	0.064	0.0003
2-methylaniline + 1 octanol	V^E (cm^3 mol^{-1})	0.586	0.160	0.188	0.0001
	Δκ$_s$ (TPa^{-1})	2.401	-0.150	0.614	0.0009
	Δη(mPa s)	-0.339	0.094	-0.007	0.0001

**Table 4(a): Coefficients of Redlich – Kister Equation and Standard Deviation
Values at 298.15 K and 308.15 K Respectively**

Binary Mixtures	Functions	A$_0$	A$_1$	A$_2$	Σ
2-methylaniline + 1 propanol	V^E (cm^3 mol^{-1})	-1.000	0.295	-0.246	0.001
	Δκ$_s$ (TPa^{-1})	-36.225	13.392	-3.740	0.008
	Δη(mPa s)	0.685	0.054	-0.156	0.003
2-methylaniline + 1 butanol	V^E (cm^3 mol^{-1})	-0.740	0.574	0.579	0.001
	Δκ$_s$ (TPa^{-1})	-26.921	5.786	-4.675	0.152
	Δη(mPa s)	0.511	-0.004	-0.377	0.001
2-methylaniline + 1 pentanol	V^E (cm^3 mol^{-1})	-0.398	0.389	0.632	0.004
	Δκ$_s$ (TPa^{-1})	-19.731	5.221	-1.689	0.044
	Δη(mPa s)	0.321	-0.009	-0.251	0.002
2-methylaniline + 1 hexanol	V^E (cm^3 mol^{-1})	0.292	0.172	-0.024	0.003
	Δκ$_s$ (TPa^{-1})	1.861	0.051	-0.369	0.005
	Δη(mPa s)	-0.101	0.090	0.117	0.001
2-methylaniline + 1 heptanol	V^E (cm^3 mol^{-1})	0.425	0.120	0.052	0.001
	Δκ$_s$ (TPa^{-1})	2.041	0.019	-0.060	0.003
	Δη(mPa s)	-0.216	0.111	0.116	0.001
2-methylaniline + 1 octanol	V^E (cm^3 mol^{-1})	0.555	0.185	0.114	0.004
	Δκ$_s$ (TPa^{-1})	2.175	-0.146	0.822	0.003
	Δη(mPa s)	-0.311	0.108	0.020	0.001